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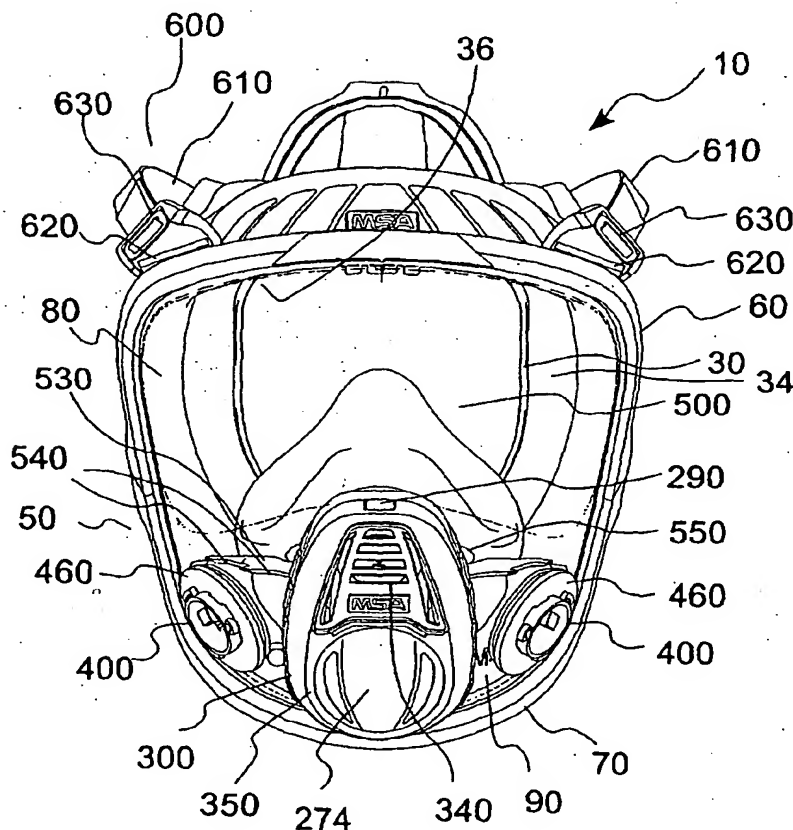
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[Continued on next page]

(54) Title: RESPIRATOR FACEPIECES



(57) Abstract: The present invention provides an air-purifying respirator facepiece with a removable, one-piece filter element connector. It also has a removable component housing in the lens as well as a nose-cup without inhalation valves that prevents fogging of the portion of the lens used for viewing.

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## RESPIRATOR FACEPIECES

### CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** This application claims benefit of U.S. Provisional Patent Application Serial No. 60,290,513 filed May 11, 2001, the disclosure of which is incorporated herein by reference.

### BACKGROUND OF THE INVENTION

**[0002]** The present invention relates generally to respirator facepieces and, more particularly, to full facepieces for use in environments in which toxic substances may be present.

**[0003]** A full facepiece, air-purifying respirator typically includes a face mask and a head harness for securing the face mask to the user. See, for example, U.S. Patent No. 5,924,420. The face mask, which is sealed to the face of the user, typically includes a lens through which the user can view the surrounding environment. The face mask also includes one or more inhalation ports in fluid connection with one or more filtering elements (for example, chemical and particulate filtering canisters or cartridges) through which inspired air passes into the face mask and an exhalation port through which expired air passes out of the mask.

**[0004]** A nose cup is typically provided around the nose and mouth area of the user to assist in directing the flow of air into and out of the face mask. The nose cup, for example, assists in directing expired air to the exhalation port, reducing buildup of carbon dioxide and in preventing expired air, which is rich in moisture, from causing "fogging" of the face mask lens. In currently available respirators, the nose cup includes one or more check valves that allow inspired air to enter the nose cup, but prevent expired air from passing through the nose cup to contact the lens. Such valves can complicate the manufacture, assembly and maintenance of the respirator.

**[0005]** One or more air filters, such as filtering canisters, filtering cartridges or other filtering elements are typically removably attachable (for example, via threading or

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via a bayonet-type connection) to connectors or interfaces attached to the face mask as part of the inhalation port(s) of the face mask. In a number of current face masks, multi-component filter element connectors are manufactured separately from the remainder of the face mask and later attached to the face mask via, for example, cooperating threaded attachment members. Filter element connectors can also be attached to the face mask via an adhesive or via a polymeric welding bond. In general, the manner in which the filter element connectors are currently attached to face masks complicates manufacturing, assembly and maintenance of such face masks.

[0006] It is therefore, desirable to develop face masks and components therefor which reduce and, preferably, eliminate the above-identified and other problems with currently available face masks.

#### SUMMARY OF THE INVENTION

[0007] In one aspect, the present invention provides a facepiece and a nose cup for use in an air-purifying respirator including a lens through which a user views a surrounding environment. The nose cup includes at least one inspiration passage open to the interior of the respirator facepiece without an intervening check valve. The inspiration passage is preferably positioned to circulate air over an inner surface of the lens and particularly the viewing area of the lens.

[0008] The respirator facepiece preferably further includes at least one inspiration port and at least one baffle to direct the flow of air entering the respirator facepiece through the inspiration port of the respirator facepiece. The baffle preferably includes a flange with at least one opening positioned adjacent an inner surface of the lens to direct the flow of air over the inner surface of the lens. The baffle can contact the inner surface of the respirator lens above the inspiration port of the respirator facepiece and below the inspiration passage of the nose cup.

[0009] The inspiration passage of the nose cup is preferably positioned below the viewing area of the lens so that any expired air exiting the inspiration passage is directed

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below the viewing area of the lens. The inspiration passage can also be positioned on a forward section of the nose cup to assist in directing the flow of air over the inner surface of the lens of the respirator facepiece. The inspiration passage can also be formed at an angle in the nose cup to direct any air expired therethrough in a downward direction, away from the viewing area of the lens. Preferably, the inspiration passage is positioned substantially below the level of a user's eyes when the respirator facepiece is worn to prevent fogging in the viewing area of the lens during use.

[0010] In another aspect, the present invention provides a respirator facepiece including a lens through which a user views a surrounding environment, at least one inspiration port formed in the lens, and a filtering element connector attachable to the facepiece. The connector is preferably fabricated from an integral piece of polymeric material and is removably connectable to the lens. For example, the connector can include a rear flange and flexible tabs positioned forward of the rear flange. The flexible tabs flex (radially) inward when a forward portion of the connector is passed through the inspiration port and flex outward upon passing over a forward surface of the lens to retain the connector in connection with the inhalation port. In that regard, the rear flange abuts an inner surface of the lens and the flexible tabs abut an outer surface of the lens. The connector can, for example, include a bayonet connection on a forward end thereof to attach a filtering element. The bayonet connection includes a plurality of spaced flanges. Preferably, a filtering element can be attached to such a bayonet connection in only one orientation. The connector can, alternatively, include a threaded connection on a forward end thereof to attach a filtering element.

[0011] In a further aspect, the present invention provides a respirator facepiece including a lens section through which a user views a surrounding environment; at least one port formed in the lens, which includes a forward extending wall section; and a respirator component housing including a seal around the periphery thereof to form a seal with an interior wall of the wall section when the component housing is seated therein. The component housing can, for example, include a channel formed around the periphery thereof in which a seal (for example, an O-ring) is seated.

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[0012] The respirator facepiece can include at least one flange positioned forward of a front surface of the wall section when the component housing is seated in the port and a retainer that seats between the front surface of the wall section and the flange to retain the component housing within the port. The retainer can, for example, be generally U-shaped to encompass a portion of the component housing.

[0013] The component housing can include an exhalation port and a check valve positioned over the exhalation port. Preferably, the exhalation port is positioned in the vicinity of the mouth of the user when the respirator is worn so that the user's voice can transmit through the check valve. The component housing can further include an inhalation port, a check valve positioned over the inhalation port, and a connector to place a filtering element in fluid connection with the inhalation port.

[0014] The present invention, along with the attributes and attendant advantages thereof, will best be appreciated and understood in view of the following detailed description taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Figure 1A illustrates a front view of one embodiment of an air-purifying respirator mask of the present invention in which the respirator mask can be fitted with two filtering cartridges on each side thereof.

[0016] Figure 1B illustrates a side, cross-sectional view of the respirator mask of Figure 1A as worn by a user.

[0017] Figure 1C illustrates a perspective or isometric disassembled or exploded view of the respirator mask of Figure 1A.

[0018] Figure 2A illustrates a front view of one embodiment of a respirator mask of the present invention in which the respirator mask can be fitted with a single filtering cartridge in the center thereof.

[0019] Figure 2B illustrates a side, cross-sectional view of the respirator mask of Figure 2A as worn by a user.

[0020] Figure 2C illustrates a perspective or isometric disassembled or exploded view of the respirator mask of Figure 2A.

[0021] Figure 3A illustrates a front view of a bayonet connector of the present invention.

[0022] Figure 3B illustrates a side, cross-sectional view of the bayonet connector of Figure 3A.

[0023] Figure 3C illustrates a side, cross-sectional view of the bayonet connector of Figure 3A as connected to the lens of the respirator mask of Figure 1A.

[0024] Figure 4A illustrates a side, cross-sectional view of an embodiment of a nose cup of the respirator mask of the present invention.

[0025] Figure 4B illustrates an opposite side view of the nose cup of Figure 4A.

[0026] Figure 4C illustrates a front view of the nose cup of Figure 4A.

[0027] Figure 4D illustrates a rear view of the nose cup of Figure 4A.

[0028] Figure 5A illustrates a front view of the component housing of the respirator mask of Figure 1A.

[0029] Figure 5B illustrates a side, cross-sectional view of the component housing of Figure 5A.

[0030] Figure 6A illustrates a front view of the component housing of the respirator mask of Figure 2A.

[0031] Figure 6B illustrates a side, cross-sectional view of the component housing of Figure 6A.

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[0032] Figure 7A illustrates a front view of the lens of the respirator mask of Figure 1A.

[0033] Figure 7B illustrates a side view of the lens of Figure 7A.

[0034] Figure 7C illustrates a top, perspective or isometric view of the lens of Figure 7A in which the lens section is shown in cross section.

[0035] Figure 7D illustrates a top view of the lens of Figure 7A.

[0036] Figure 8 illustrates a front view of the lens of the respirator mask of Figure 2A.

[0037] Figure 9A illustrates a front view of the respirator mask of Figure 1A without a harness section attached thereto.

[0038] Figure 9B illustrates a side view of the respirator mask of Figure 1A without a harness section attached thereto.

[0039] Figure 9C illustrates a rear view of the respirator mask of Figure 1A without a harness section attached thereto.

[0040] Figure 9D illustrates a bottom view of the respirator mask of Figure 1A without a harness section attached thereto.

[0041] Figure 9E illustrates a top view of the respirator mask of Figure 1A without a harness section attached thereto.

## DETAILED DESCRIPTION OF THE INVENTION

[0042] Figures 1A through 1C and Figures 9A through 9E illustrate one embodiment of a full facepiece respirator mask 10 of the present invention to which two filtering elements (for example, filtering canisters or filtering cartridges) can be mounted on the sides thereof. Figure 2A through 2C illustrate another embodiment of a full



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facepiece respirator mask 10' of the present invention to which one filtering element can be mounted generally in the center thereof.

[0043] Returning to the embodiment of Figures 1A through 1C and Figures 9A through 9E, respirator mask 10 includes a face blank 20 (fabricated, for example, from a silicon rubber) that includes a rear opening 30 which seals around the face of a user. In general, opening 30 includes a chin cupping section 32 that seals around the chin area of the user, side sections 34 that seal around the sides of the user's face and a forehead section 36 that seals around the forehead of the user (see, for example, Figure 9C). Face blank 20 further includes a forward opening or rim 40 that seals to a lens 50 of respirator mask 10. Face blank 20 can, for example, be sealingly attached to lens 50 via a peripheral rim or ring comprising an upper rim or ring member 60 and a lower rim or ring member 70, which can, for example, be connected together (via, for example, fasteners such as screws). Rim members 60 and 70 encompass and maintain in sealing, abutting engagement, rim 40 of face blank 20 and a rim 52 of lens 50 (see, for example, Figure 1B).

[0044] Respirator mask 10 can, for example, have attached thereto an adjustable harness section 600 to encompass the head of the user and to maintain face blank 20 of respirator mask 10 in sealing engagement with the face of the user (see, for example, Figure 1B). In the embodiment of Figures 1A through 1C, harness section 600 includes upper straps 610, which connect to clips 620 attached to or formed upon an upper rim member 60 via, for example, buckles 630. Lower straps 650 connect to an extending flange or button 660 formed on or attachable to an rearward extension 670 of face blank 20.

[0045] Lens 50 includes an upper lens section 80 through which the user views the surrounding environment and a lower respiration section 90 to which respiration/filtering components as described below are attachable. In one embodiment, each of upper section 80 and lower section 90 were formed integrally from optical quality, transparent polycarbonate. In the embodiment of Figures 1A through 1C, lower section 90 includes a generally central port or opening 100 and two side openings or

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ports 110 formed therein. Port 100 is formed in the forward end of an extending wall section 120 that extends forward from the remainder of lower section 90.

[0046] A respirator component housing 200 is removably attachable to forward extending section 120. In that regard, housing 200 includes a seal around the periphery thereof that forms a sealed engagement, fit or connection with the internal wall of extending section 120. Housing, 200 can, for example, include a channel or groove 210 around the periphery thereof in which a sealing member (for example, a standard O-ring 220) is seated. A seal can also, for example, be formed integrally around the periphery of housing 200 from a polymeric material suitable to form a sealing connection with extending section 120. Housing 200 and O-ring 220 are dimensioned such that O-ring 220 forms a sealing engagement, fit or connection with the inner wall of forward extending section 120 when housing 200 (with O-ring 220 seated in channel 210) is inserted into extending section 120 from the rear. Housing 200 of the present invention can be of generally any shape to sealingly seat in a port of virtually any cooperating shape, whereas many currently available housings for use in respirator masks are limited in shape (for example, many must be rounded to be equipped with cooperating threading). Housing 200 of the present invention can be shaped, for example, to optimize visibility of the user of respirator mask 10 by appropriately positioning a filtering cartridge attached thereto.

[0047] After housing 200 is seated in extending section 120, a retainer such as retaining clip 230 is attached to housing 200 to retain housing 200 in position within extending section 120. In the embodiment of Figures 1A through 1C, retaining clip 230 is formed of a flexible or resilient polymeric material and forms a snap fit with housing 200. In that regard, generally U-shaped retaining clip 230 is slid upward and around housing 200 to seat in a gap formed between a forward surface 130 of extending section 120 and a flange or flanges 240, 250 and 260 formed on housing 200. Housing 200 can be removed from connection with extending section 120, simply by manually spreading one or both of extending arms 232a and 232b of retaining clip 230 and sliding retaining clip 230 out of connection with housing 200. Housing 200 can then

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be pushed rearward to disconnect the sealing engagement formed between O-ring 220 and the inner wall of extending section 120.

[0048] Housing 200 also includes an exhalation port 270 to which an elastomeric flap valve 280 (as known in the art) is connected via cooperation of a rearward extending tab 282 (see, for example, Figure 1B) of valve 280 and a generally central passage 272 formed in exhalation port 270. Valve 280 opens very easily upon exhalation by a user of respirator mask 10 but closes upon inspiration to prevent inspired air from passing through exhalation port 270. Exhalation port 270 is preferably positioned generally directly in front of the mouth of the user to facilitate transmission of expired air and to facilitate transmission of and understanding of the speech of the user. In that regard, sound waves are transmitted comparatively well through valve 280 of exhalation port 270. In current respirator masks or face masks, a KAPTON® (polyimide) diaphragm or a very thin section of plastic are provided in the face mask or in a component housing thereof to provided for voice transmission. Transmission of the user's voice through an exhalation port positioned generally in front of the user's mouth simplifies manufacture and reduces cost without sacrificing performance. In the embodiment of Figures 1A through 1C, exhalation port 270 is formed in a well in housing 200 to improve the resonance of the user's voice as transmitted therethrough. Housing section 200 can, for example, be injection molded as an integral part from a polymeric material such as, for example, a polycarbonate, a polyester or, preferably, a polycarbonate/polyester blend.

[0049] Respirator mask 10 also includes a housing cover 300 that is attached to housing 200 by first passing a tab 290 formed on the upper end of housing 200 through a passage 310 form in the upper end of cover 300, and then applying rearward force to a lower end (for example, to flange 320) of cover 300 to form a snap fit between cover 300 and housing 200 via cooperation of a passage 330 (see, for example, Figure 1B) formed in the lower end of cover 300 and tab 292 (see, for example, Figure 1B) extending from a lower end of retainer 230. Cover 300 can, for example, be injection molded as an integral part from a resilient polymeric material such as , for example, a polycarbonate, a polyester or, preferably, a polycarbonate/polyester blend.. To remove cover 300 from

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connection with housing 200, the user can compress areas 340 on each side of cover 300 to deform housing cover 300 and enable disconnection of tab 292 from passage 330. Housing cover 300 includes a vent 340 to allow expired air and voice transmission from exhalation port 270 to pass therethrough.

[0050] Respirator mask 10 also includes one or more connectors such as bayonet-type connectors 400 that are preferably removably connected to lens 50 via inspiration ports 110. Although, connectors 400 are illustrated, for example, in Figures 1A through 1C as bayonet-type connectors, one skilled in the art understands that other types of connectors such as, for example, threaded connectors (that is, connectors including threading on a forward section thereof for cooperative attachment to a threaded filtering element) can be used in the present invention. Filtering element connectors 400 are operable to attach filtering elements such as cartridges or canisters as known in the art. Connectors 400 are, for example, removably connectable to lens 50 via cooperation of slots 112 formed around the periphery of inhalation ports 110 and flexible leaf springs or abutment tabs 410 (see, for example, Figures 3A through 3C) disposed around connectors 400. To attach connector 400 to face lens 50, connector 400 is pushed through inhalation ports 110 from the rear with tabs 410 aligned with slots 112. A sloped surface 412 of tabs 410 contacts the radial outward edge of slots 112, causing tabs 410 to flex radially inward. Once tabs 110 pass the forward edge of slots 112, tabs 112 flex radially outward to abut a ledge 114 formed in slots 112 (see Figure 3C). Abutment of a rearward flange 420 of connectors 400 with lens wall 116 in the area of inhalation ports 110 and abutment of tabs 410 with ledges 114 of slots 112 retains connectors 400 in connection with lens 50.

[0051] Preferably, bayonet-type connectors are aligned in a predetermined rotational position within inhalation ports 110 so that cartridges (not shown), which may be of varying shapes and sizes are connected thereto in a manner that does not interfere with the vision of the user of respirator mask 10. Connectors 400 can, for example, include indicator tabs or flanges 430 that align with a uniquely dimensioned slot 118 formed around the periphery of inhalation ports 110 to properly align connectors 400 within inhalation ports 110. Connectors 400 include flanges such as flanges 440a, 440b

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and 440c to connect a cartridge or canister via a bayonet connection as known in the art. One or more of flanges 440a, 440b and 440c can be uniquely dimensioned or shaped to allow connection of a cartridge or canister in only a desired orientation. In the present embodiment, flange 440a is uniquely shaped and/or dimensioned.

[0052] A gasket 450, as known in the art, can be provided to assist in forming a seal between the cartridge and the forward surface of lens 50. In that regard, gasket 450 is compressed between the cartridge and lens 50 when the cartridge is connected to connector 400.

[0053] A passage 460 is formed through the center of connector(s) 400 to allow air drawn through an attached cartridge to pass into respirator mask 10 through inhalation port 110 of lens 50 during inhalation by the user. A one-way check valve such as an elastomeric flap valve 480 can be placed over the rearward end of passage 460 to allow inspired air into lens 50 through passage 460, but to prevent expired air from exiting lens 50 through passage 460. Valve 480 can, for example, be attached to bayonet connector 400 via a rearward flange 470 that cooperates with a passage 482 formed generally centrally in the elastomeric check valve 480.

[0054] Connectors 400 are preferably removable by flexing tabs 410 radially inward to allow connectors 400 to be forced rearward, through inhalation ports 110. A damaged bayonet connector 80 can, for example, be readily replaced. In currently available respirator masks in which such connectors are adhered or welded (for example, via polymer welding bonds such as an ultrasonic welding bond) to a respirator mask, such replacement is not possible. Moreover, in case that a connector is adhered or welded to a respirator mask (for example, to the lens thereof) the material of the connector and the material of the respirator mask component to which the connector is adhered or welded must be the same or closely matched, which significantly limits the choice of materials for the connector. In the present invention, however, no such material matching is required and very strong and durable materials can be chosen for connectors 400. In other currently available respirator masks in which filtering element connectors are removable, such removable connectors are manufactured in two or more

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cooperating pieces or components, causing additional manufacturing complexity, time and cost, whereas connectors 400 can, for example, be injection molded from an integral piece of polymer materials such as polypropylene, nylon, or, preferably, glass-filled nylon.

[0055] Respirator mask 10 also includes a nose cup 500 (see, for example, Figures 1A through 1C and Figures 4A through 4D) that assists in directing the flow of air into, within and out of respirator mask 10. Nose cup 500 can, for example, be formed integrally from an elastomeric polymeric material such as a thermal plastic elastomer (for example, SANOPRENE, VERSAFLEX® OR KRATON®). Prior to connecting component housing 200 to lens 50 as described above, nose cup 500 can be attached to housing 200 from the rear by, for example, extending or stretching a forward exhalation port or opening 510 of nose cup 500 around a flange 296 formed on the upper, rear of housing 200 to place port 510 in connection with exhalation port 270. Alternatively, nose cup 500 can be attached to housing 200 after housing 200 is connected to lens 50.

[0056] An upper rear flap 520 around the upper, rear periphery of nose cup 500 contacts and generally encompasses the nose section of the user when respirator mask 10 is donned. Rear flap or flange 520 also contacts face blank 20. A lower, chin portion of nose cup 500 passes below chin section 32 of face blank 20 as illustrated, for example, in Figure 1B. A lower baffle or flange 530 of nose cup 500 preferably contacts the inner surface of lower section 90 of lens 50. During inhalation, air is drawn through inhalation ports 110 (that is, through a filtering cartridge connected to bayonet connector 400). Check valve 480 opens and check valve 280 closes during inhalation. Flange or baffle 530 directs the inspired air over the interior wall of lens 50, through baffle openings 540 formed in baffle 530 and through inspiration openings 550 formed in nose cup 500.

[0057] During exhalation, a positive pressure within respirator mask 10 (caused, in part, by closed inhalation check valves 480) generally prevents moisture laden expired air from passing through inspiration openings 550, and the majority of expired air passes directly through exhalation port 27 via open exhalation check valve 280. Expired air that

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does pass through inspiration openings 550 can cause only minimal fogging of lens 50 well below the viewing area of lens section 80, for example, because of the positioning of inspiration openings 550 below the eyes of the user and below the viewing area of lens section 80. As illustrated, for example, in Figure 4D, inspiration openings 550 can also be angled or oriented downward to assist in directing any expired air passing therethrough downward and away from the viewing area of lens section 80. Thus, any fogging does not hamper the view of the user of respirator mask 10. In comparison, many currently available nose cups for use in currently available respirator masks have inspiration openings on the top of the nose cup or elsewhere and require check valves to prevent carbon dioxide buildup within the respirator mask and to prevent expired air from contacting the lens of the respirator mask and causing fogging. Such check valves are unnecessary in respirator mask 10. Moreover, any minimal fogging that may occur out of the viewing area of lens section 80, occurs in the vicinity of inspiration openings 550, and is quickly cleared by air inspired on the next breath, which passes over the inner surface of lens 50 as directed by baffle openings 540 and by inspiration openings 550. The circulation of air over the inner surface of lens 50 also prevents buildup of carbon dioxide in respirator mask 50.

[0058] Inspiration openings 550 of nose cup 550 are, for example, preferably placed on a forward area of nose cup 550 so as to be generally forward facing and generally close in position to the inner surface of lens 50, thereby causing circulation of air over the inner surface of lens 50. Moreover, baffle openings 540 are preferably positioned adjacent to the inner surface of lens 50 and preferably do not extend very far rearward from the inner surface of lens 50 to cause circulation of air passing through baffle openings 540 over the inner surface of lens 50 and, particularly, over the inner surface of upper lens section 80. The discovery of the present inventors that lens fogging and carbon dioxide buildup can be avoided or prevented using a nose cup having inspiration openings or ports open to the interior of a respirator mask without intervening check valves is quite surprising.

[0059] Nose cup 500 can, for example, include a number of ridges 560 or other structural features to add strength thereto and to maintain the shape thereof. Ridges 560

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can also increase the size range of a particular nose cup 500 by expanding/contracting or accordioneing to conform nose cup 500 to a range of user sizes.

[0060] Another or alternative embodiment of a respirator mask 10' of the present invention is illustrated in Figures 2A through 2C. In general, many of the components of respirator mask 10' are identical to those of respirator mask 10 and those components are designated by the same numbering as used above. Other components are modified to varying degrees and are designated with a similar number, but with the designation "'". As discussed above, the primary difference between respirator mask 10' and respirator mask 10 is that respirator mask 10 includes only one, generally central port, which cooperates with inhalation and exhalation ports formed in component housing 200' as described below.

[0061] Respirator mask 10' includes face blank 20 as described above which seals around the face of a user. Figures 2A and 2B illustrate harness section 600 attached to respirator mask 10'. In Figure 2C, an alternative harness section 700 (which can be used with either of respirator masks 10 or 10') is illustrated connected to face blank 20 and to upper ring member 60.

[0062] As described above, forward opening or rim 40 of face blank 20 seals to a lens 50' of respirator mask 10'. Rim members 60 and 70 encompass and maintain in sealing, abutting engagement, rim 40 of face blank 20 and a rim 52' of lens 50' (see, for example, Figure 2B).

[0063] As described for lens 50, lens 50' includes an upper lens section 80' through which the user views the surrounding environment and a lower respiration section 90' to which respiration/filtering components as described below are attachable. Upper lens section 80', and lower section 90', are formed integrally from optical quality, transparent polycarbonate. In the embodiment of Figures 2A through 2C, lower section 90' includes only a generally central port or opening 100' for connection of housing 200' thereto. In general, lens 50 and lens 50' are formed using very similar molds, other than ports 110 of lens 50 are not formed in lens 50'. In that regard, lens 50'



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is formed with solid sections or blanks 110' at the positions in which ports 110 are formed in lens 50.

[0064] Respirator component housing 200' is removably attachable to a forward extending section 120' of port 100 as described above for housing 200. In that regard, housing 200' can include a channel or groove 210' around the periphery thereof in which a sealing member such as standard O-ring 220 is seated. Housing 200' and O-ring 220 are dimensioned such that O-ring 220 forms a sealing engagement, connection or fit with the inner wall of forward extending section 120' when housing 200' (with O-ring 220 seated in channel 210') is inserted into extending section 120' from the rear. After housing 200' is seated in extending section 120', retaining clip 230 is attached to housing 200' to retain housing 200' in position within extending section 120'.

[0065] Housing 200' also includes an exhalation port 270' to which elastomeric flap valve 280 is connected as described above. Housing 200' further includes an inhalation port 274' having threading 276' formed around the interior thereof which cooperates with threading 810 of a filtering cartridge 800 to connect cartridge 800 to inhalation port 274'. Other types of connections as known in the art (for example, bayonet connections as described above) can also be used to attach a filtering cartridge. Housing cover 300 is attached to housing 200' as described above so that vent 340 is in fluid connection with exhalation port 270' and opening 350 is in fluid connection with inhalation port 274'.

[0066] Housing 200' can, for example, be injection molded from a polymeric material in generally the same manner and form as housing 200. However, housing 200' is formed with threaded inhalation port 274' therein whereas housing 200 includes a solid blank 274 in the area of inhalation port 274' (see, for comparison, Figures 1A through 1C, Figures 2A through 2C, Figures 5A through B and Figures 6A through 6B).

[0067] Likewise, lens 50 and lens 50' can, for example, be injection molded from a polymeric material (for example, a transparent polycarbonate) in generally the same manner to have generally the same overall shape and dimensions (see, for example, Figures 7A through 8). As described above, lens 50' includes solid blanks 110', whereas

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lens 50 is formed with inhalation ports 110 in the same area. Otherwise, the shape and dimensions of lens 50 and lens 50' are generally identical. Manufacture of components of respirator masks 10 and 10' with similar molds and with a number of interchangeable components reduces manufacture costs as compared to substantially differing designs.

[0068] The foregoing description and accompanying drawings set forth the preferred embodiments of the invention at the present time. Various modifications, additions and alternative designs will, of course, become apparent to those skilled in the art in light of the foregoing teachings without departing from the scope of the invention. The scope of the invention is indicated by the following claims rather than by the foregoing description. All changes and variations that fall within the meaning and range of equivalency of the claims are to be embraced within their scope.

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## WHAT IS CLAIMED IS:

1. A respirator facepiece comprising:  
  
a lens through which a user views a surrounding environment; and  
  
a nose cup including at least one inspiration passage open to the interior of the respirator facepiece without an intervening check valve, the inspiration passage being positioned to circulate air over a viewing area of the lens.
2. The respirator facepiece of claim 1 further comprising at least one inspiration port formed in the lens and a baffle to direct the flow of air entering the respirator facepiece through the inspiration port.
3. The respirator facepiece of claim 2 wherein the baffle comprises a flange with at least one opening positioned adjacent an inner surface of the lens to direct the flow of air over the viewing area of the lens.
4. The respirator facepiece of claim 2 wherein the inspiration passage is positioned below the viewing area of the lens to direct any expired air exiting the inspiration passage below the viewing area of the lens.
5. The respirator facepiece of claim 4 wherein the inspiration passage is positioned on a forward section of the nose cup.
6. The respirator facepiece of claim 5 wherein the baffle contacts the inner surface of the lens above the inspiration port of the respirator facepiece and below the inspiration passage of the nose cup.
7. The respirator facepiece of claim 2 wherein the inspiration passage is angled to direct any air expired therethrough in a downward direction, away from the viewing area of the lens.
8. The respirator facepiece of claim 2 wherein the inspiration passage is below the level of a user's eyes when the respirator facepiece is worn.

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9. A respirator facepiece comprising:

a lens through which a user views a surrounding environment;

at least one inspiration port formed in the lens; and

a filtering element connector attachable to the facepiece, the connector being fabricated from an integral piece of polymeric material, the connector including a rear flange and flexible tabs positioned forward of the rear flange, the flexible tabs flexing inward when a forward portion of the connector is passed through the inspiration port and flexing outward upon passing over a forward surface of the lens to retain the connector in connection with the inspiration port, wherein the rear flange abuts an inner surface of the lens and the flexible tabs abut an outer surface of the lens.

10. The respirator of claim 9 wherein the connector includes a bayonet connection on a forward end thereof for attachment of a filtering element.

11. The respirator of claim 10 wherein the bayonet connection includes a plurality of spaced flanges.

12. The respirator of claim 11 wherein the filtering element can be attached to the bayonet connection in only one orientation.

13. The respirator of claim 9 wherein the connector includes a threaded connection on a forward end thereof for attachment of a filtering element.

14. A respirator facepiece comprising;

a lens through which a user views a surrounding environment;

at least one port formed in a lower section of the lens, the port including a forward extending wall section; and

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a respirator component housing including a seal around the periphery thereof to form a seal with an interior wall of the wall section when the component housing is seated therein.

15. The respirator facepiece of claim 14 wherein the component housing includes a channel formed around the periphery thereof and the seal is seated in the channel.

16. The respirator facepiece of claim 14 wherein the component housing comprises at least one flange positioned forward of a front surface of the wall section when the housing is seated in the port and the respirator facepiece further comprises a retainer that seats between the front surface of the wall section and the flange to retain the housing within the port.

17. The respirator facepiece of claim 16 wherein the retainer is generally U-shaped to encompass a portion of the component housing.

18. The respirator facepiece of claim 13 wherein the component housing includes an exhalation port and a check valve positioned over the exhalation port, the exhalation port being positioned in the vicinity of the mouth of the user when the respirator is worn so that the user's voice can transmit through the check valve.

19. The respirator of claim 18 further comprising an inhalation port, a check valve positioned over the inhalation port, and a connector to place a filtering element in fluid connection with the inhalation port.

Fig. 1A

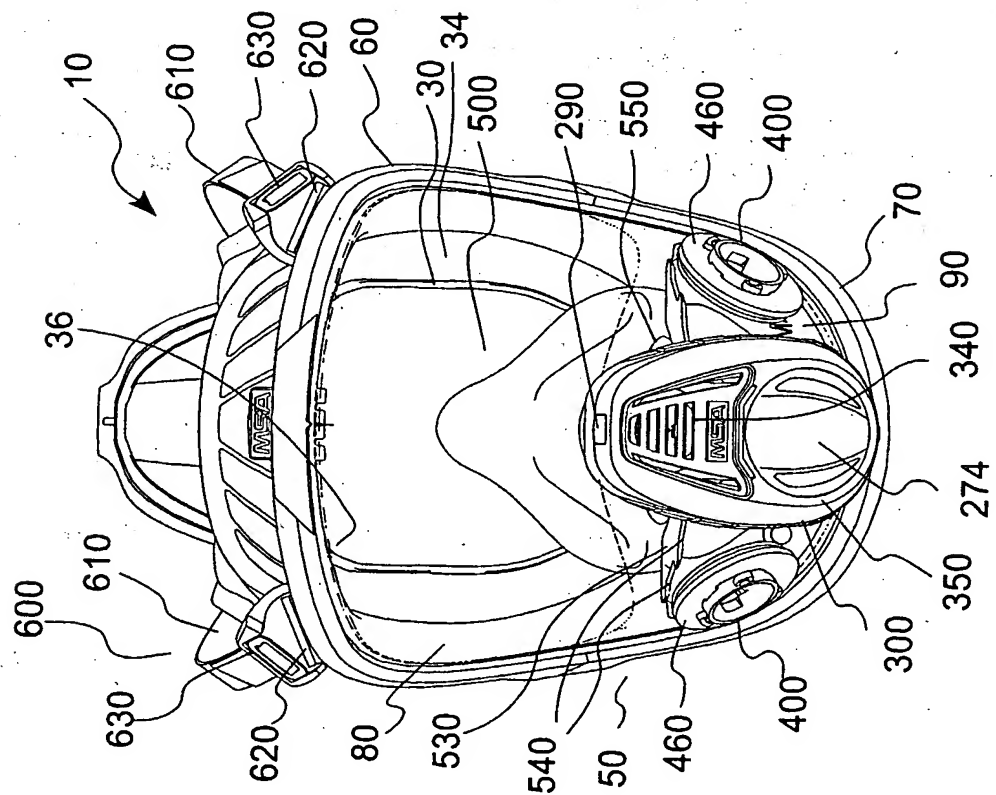
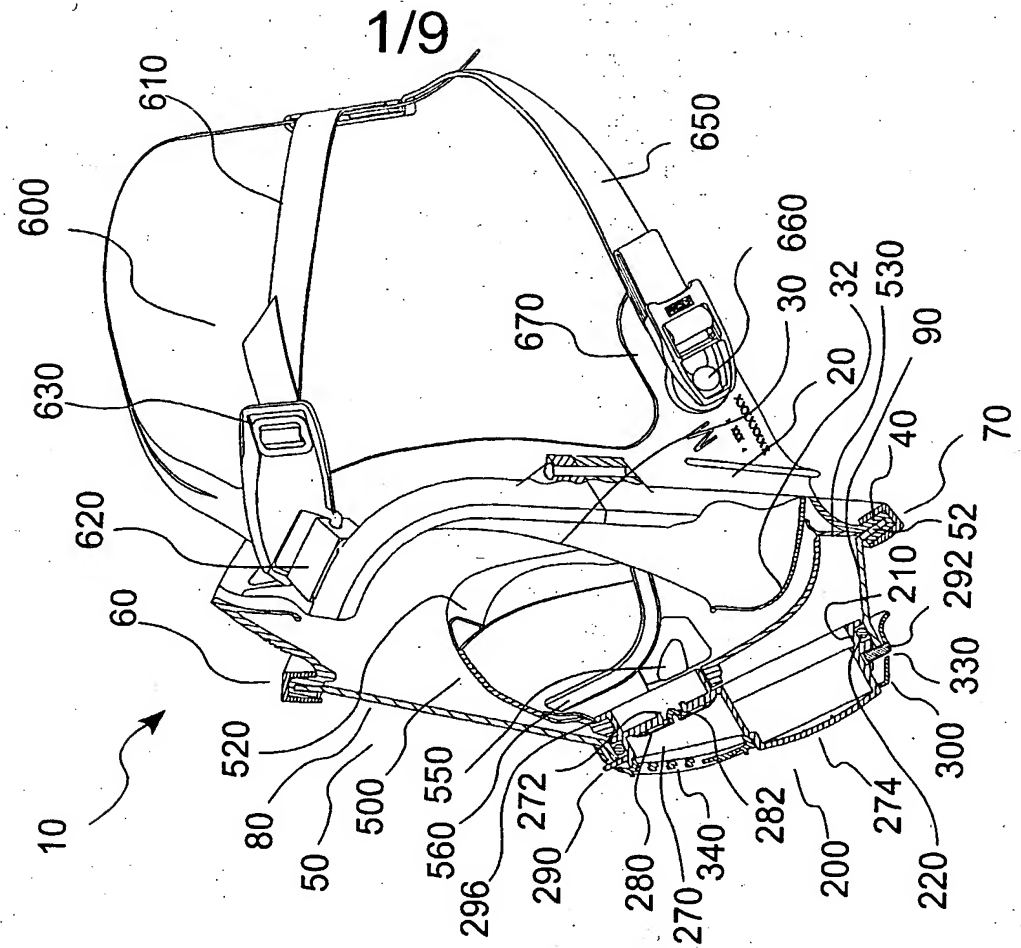
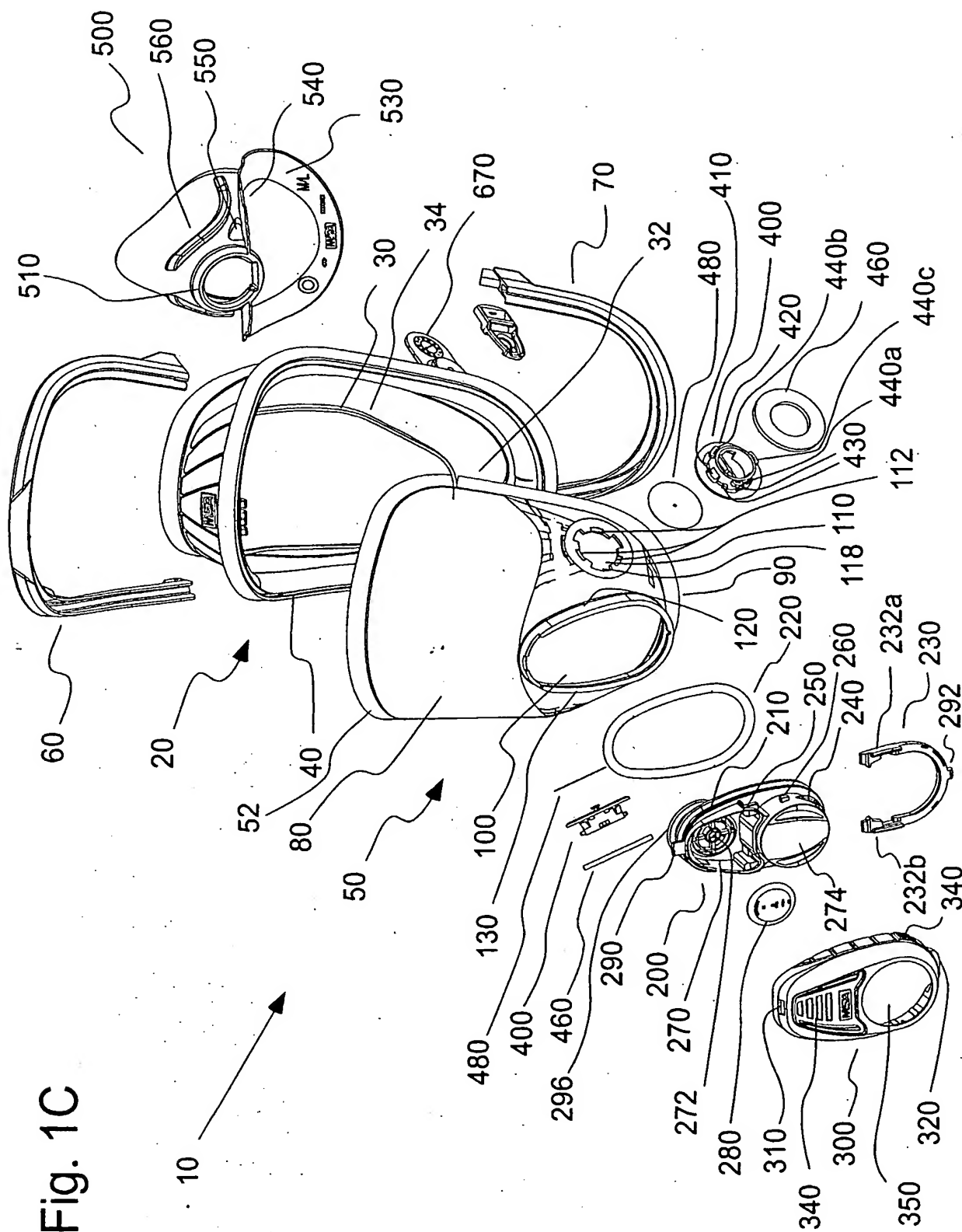


Fig. 1B





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Fig. 2B

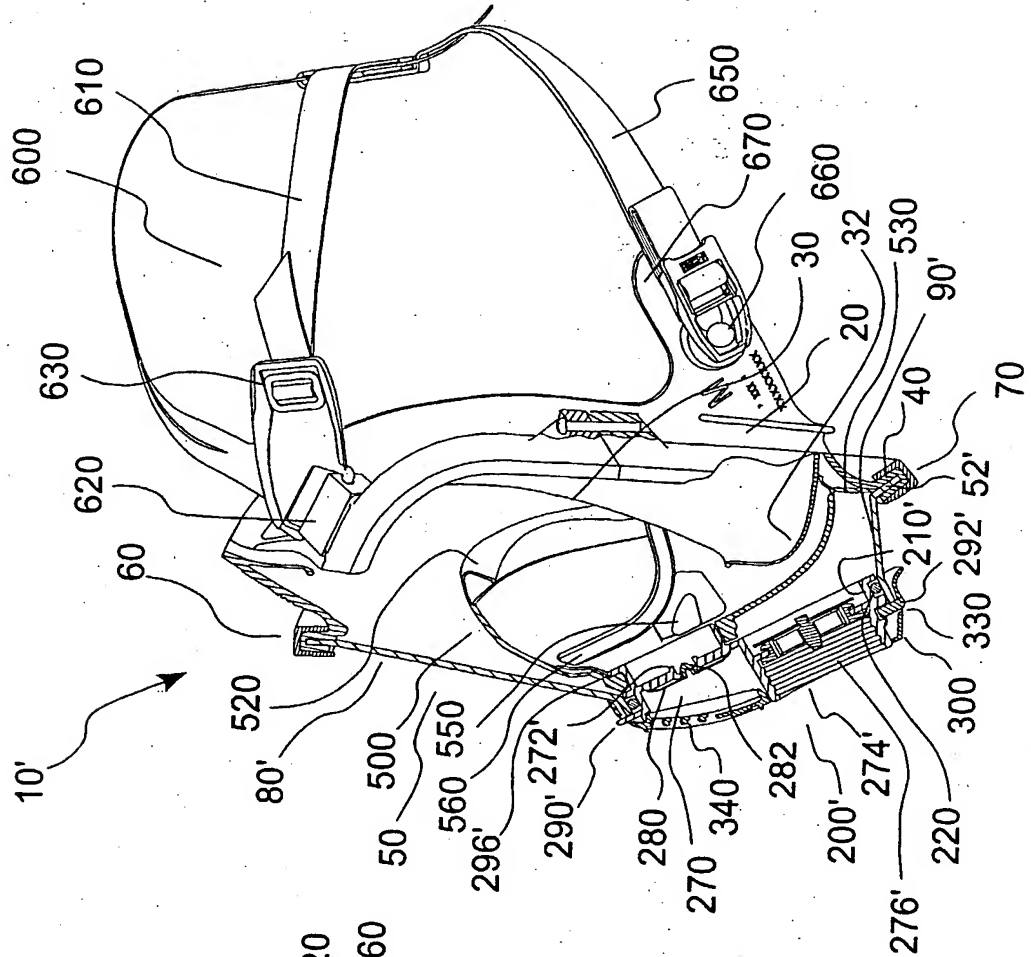
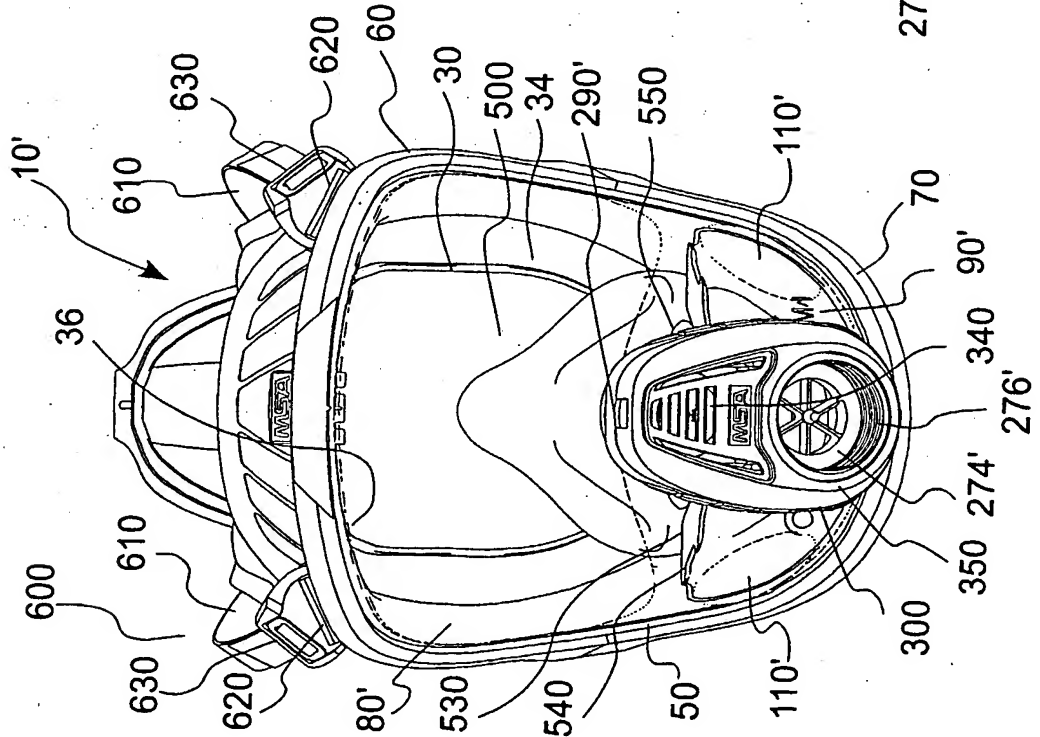
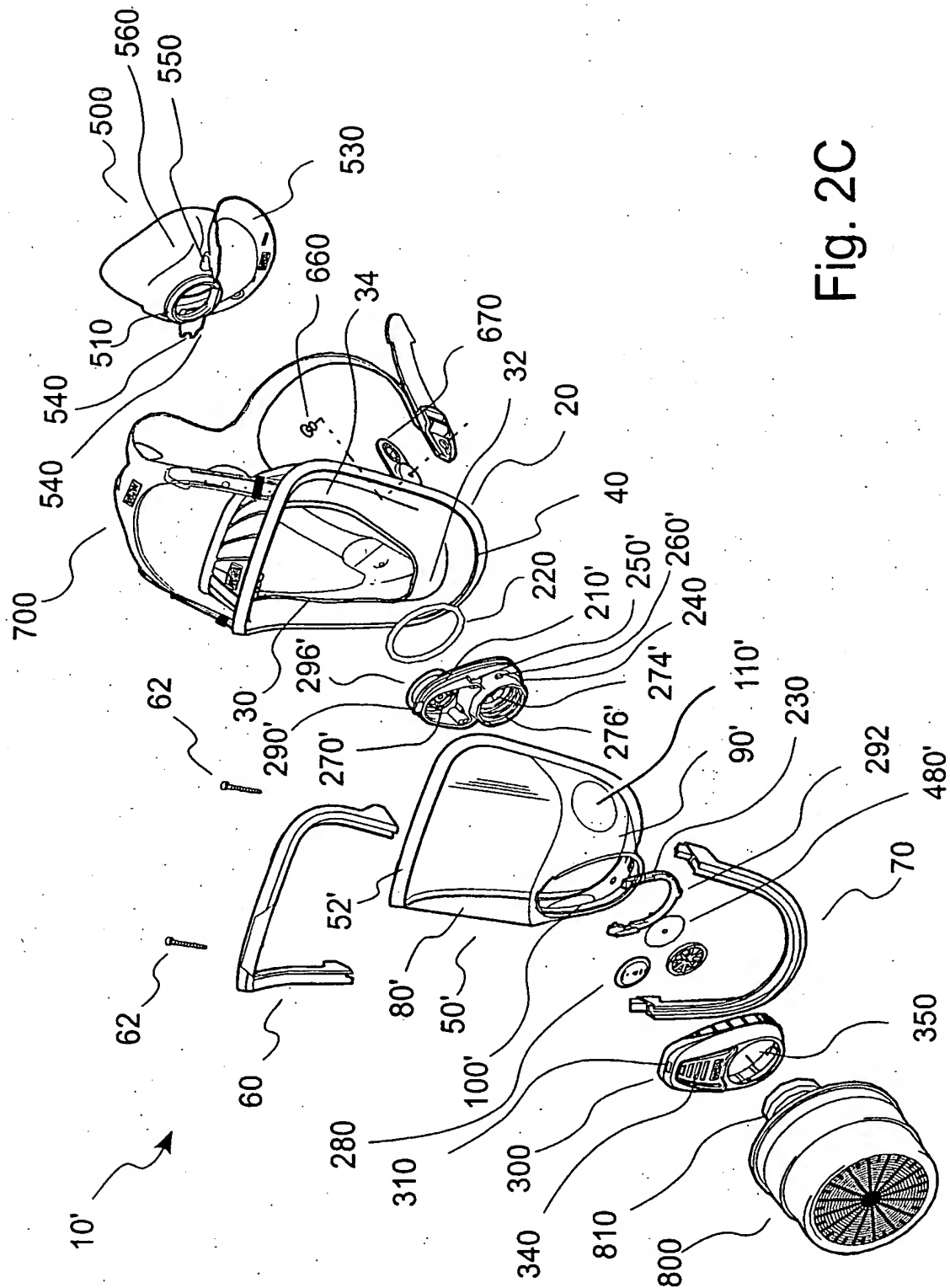


Fig. 2A

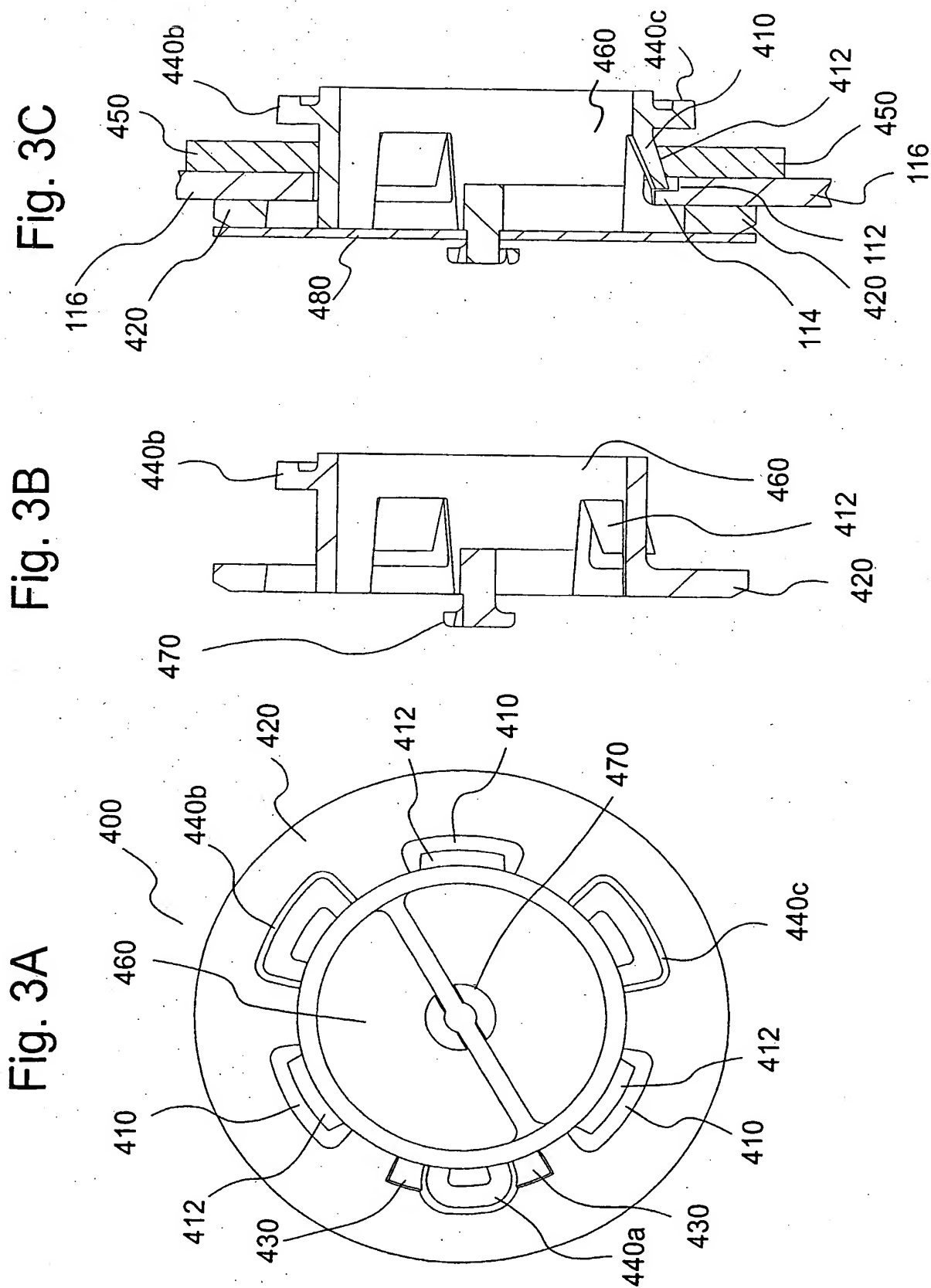




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Fig. 4A

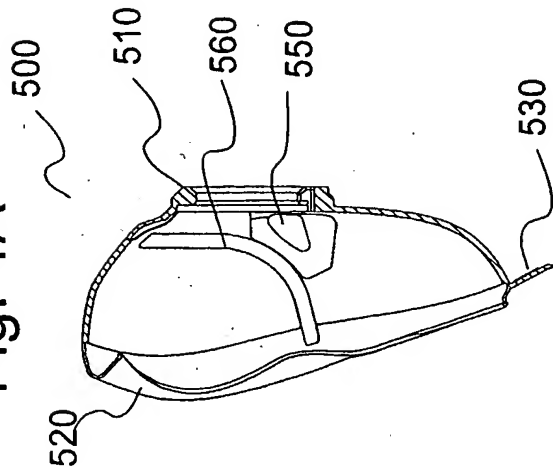


Fig. 4C

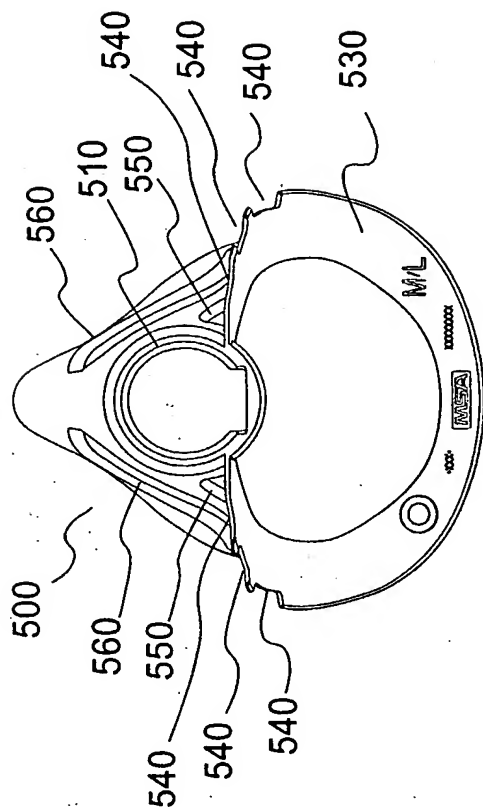


Fig. 4B

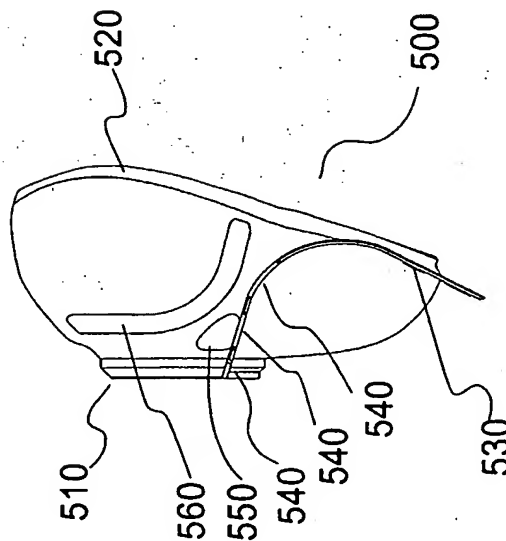
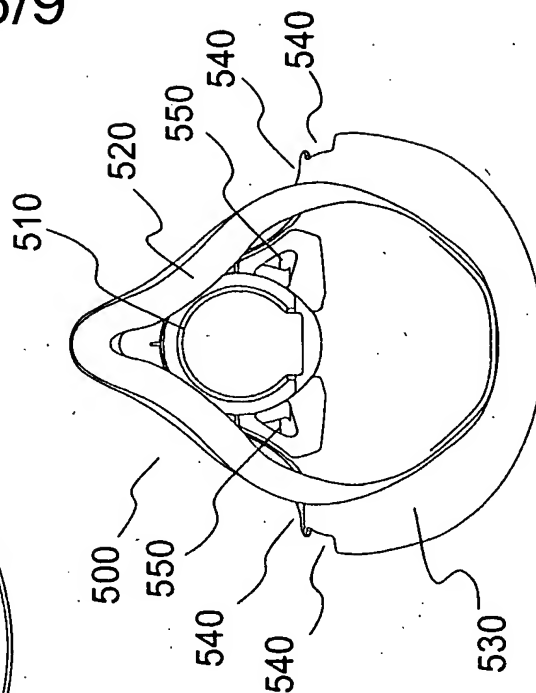


Fig. 4D



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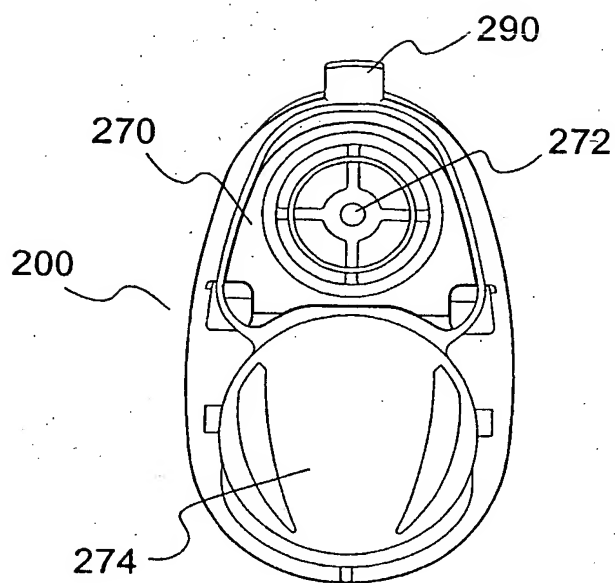


Fig. 5A

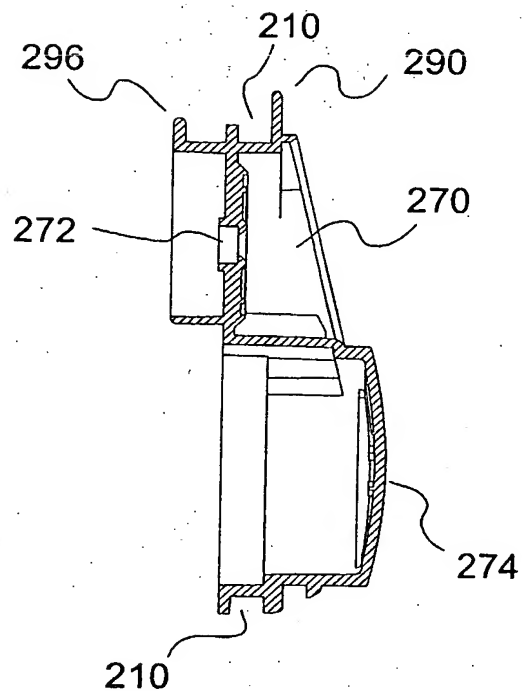


Fig. 5B

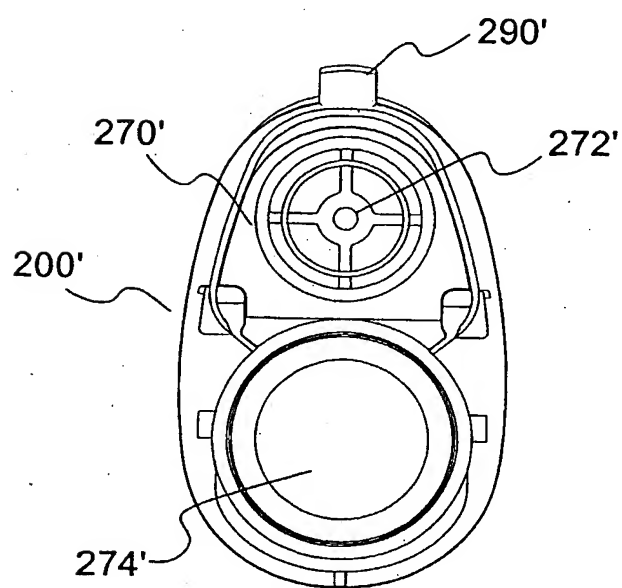


Fig. 6A

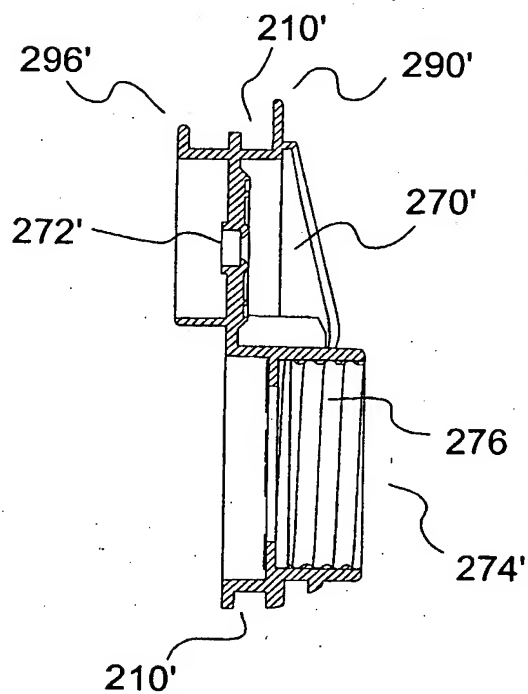


Fig. 6B

Fig. 7B

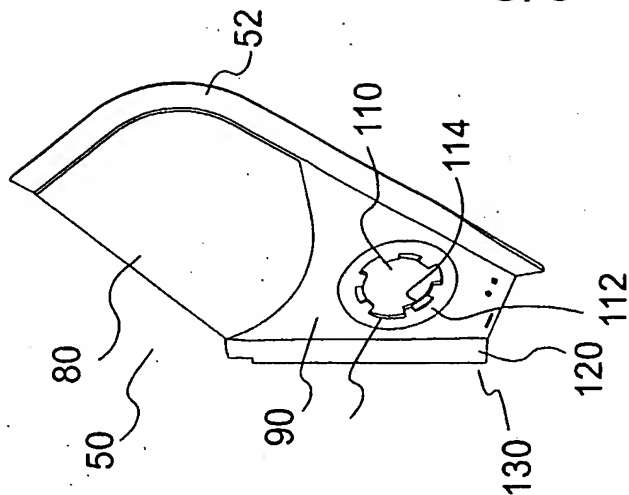


Fig. 7A

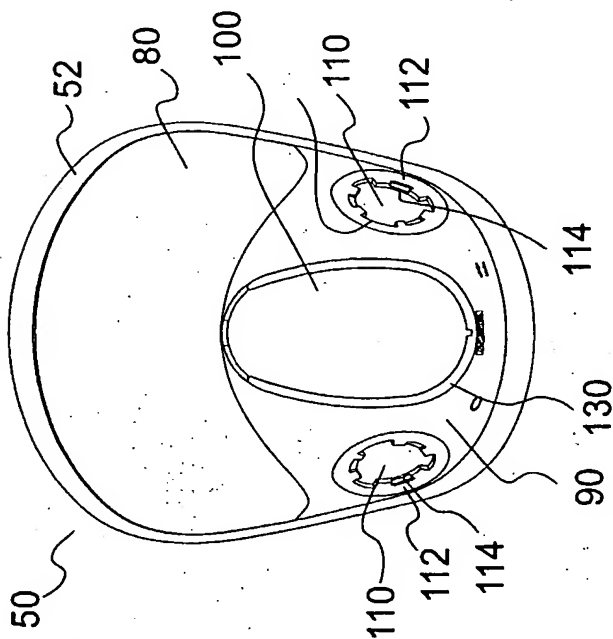


Fig. 8

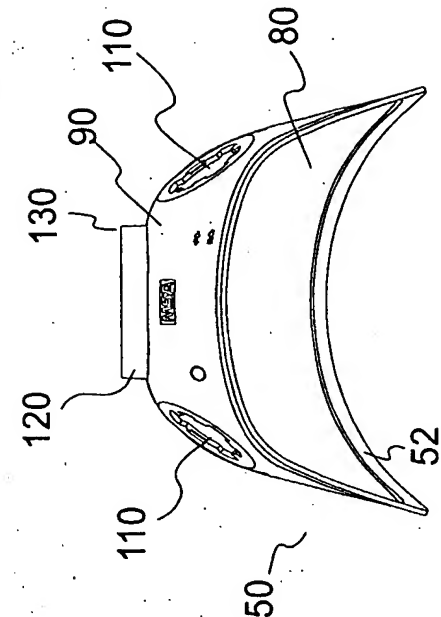
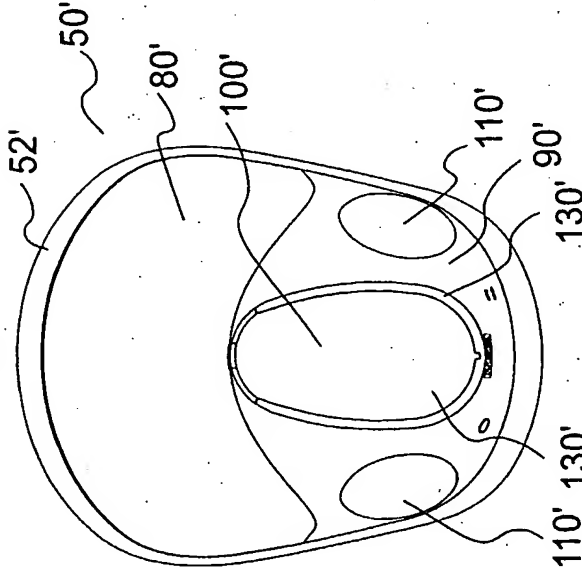


Fig. 7D

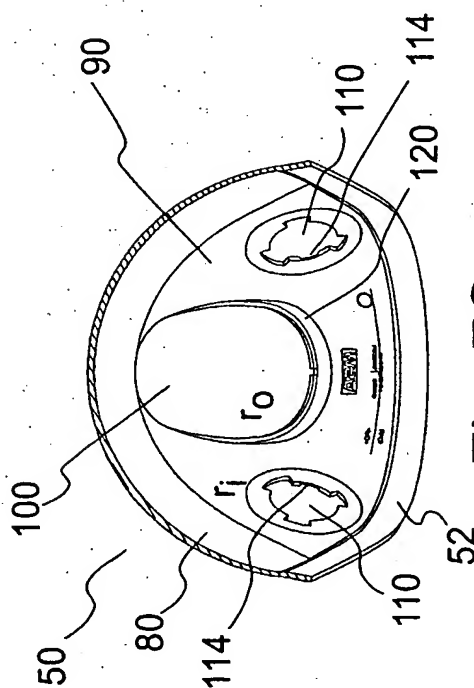


Fig. 7C

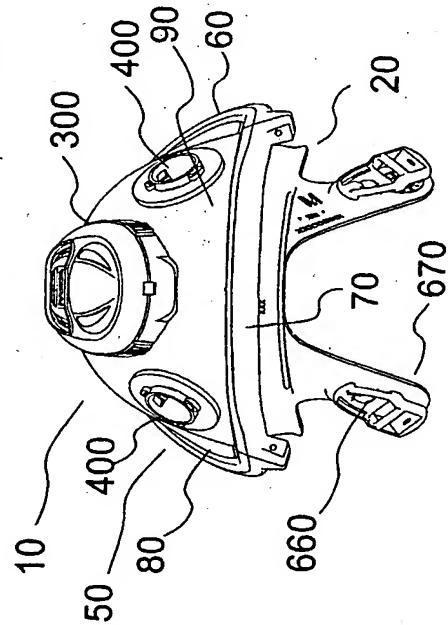
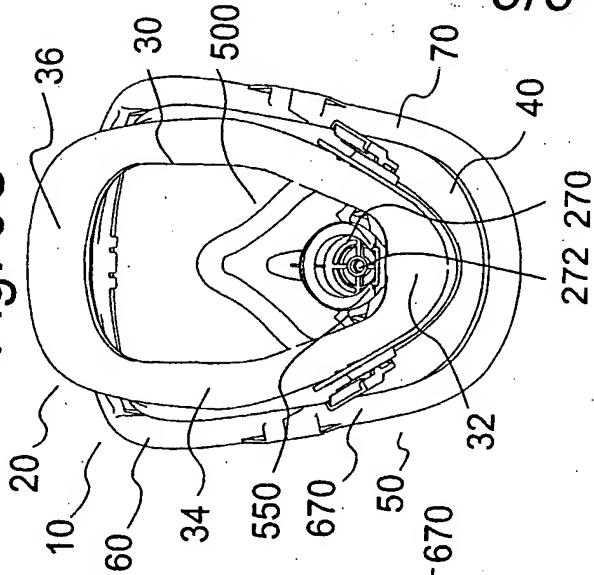
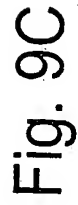
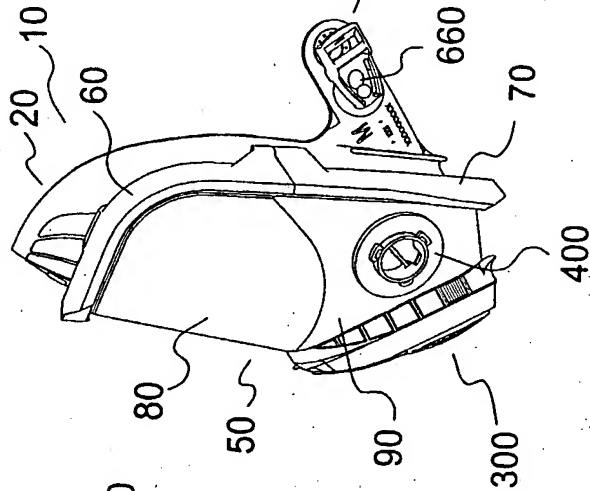
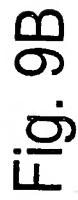
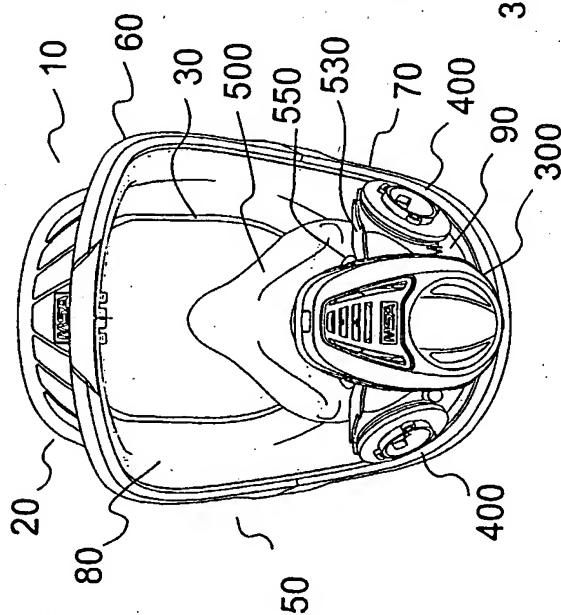
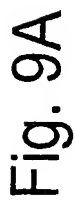


Fig. 9D

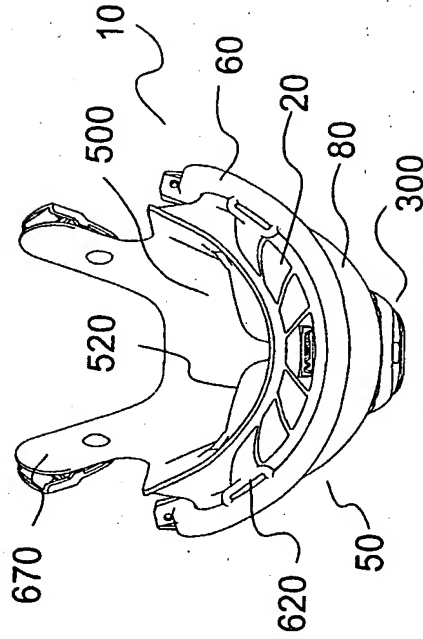


Fig. 9E

(19) World Intellectual Property Organization  
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21 November 2002 (21.11.2002)

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(51) International Patent Classification<sup>7</sup>: **A62B 18/08**

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(21) International Application Number: **PCT/US02/15015**

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(74) Agent: **UBER, James, G.**; Mine Safety Appliances Company, P.O. Box 426, Pittsburgh, PA 15230-0426 (US).

(25) Filing Language: **English**

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW.

(26) Publication Language: **English**

(30) Priority Data:  
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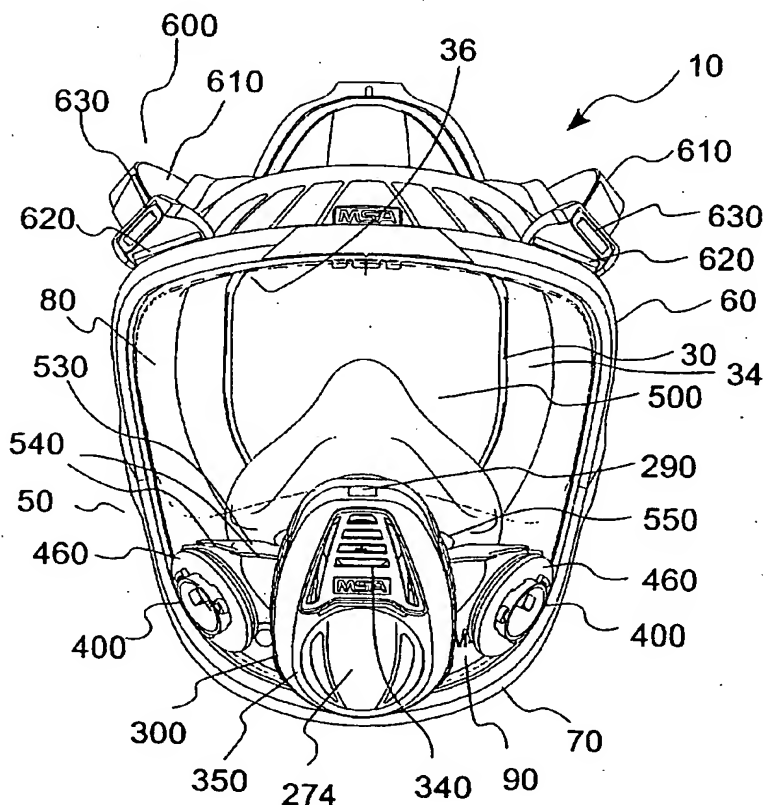
(71) Applicant: **MINE SAFETY APPLIANCES COMPANY [US/US]**; P.O. Box 426, Pittsburgh, PA 15230-0426 (US).

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent

(72) Inventors: **KIEFER, Eileen, A.**; 117 Sunridge Drive, Pittsburgh, PA 15216 (US). **CAVALIERE, Mark**; 1360 Duncan Avenue, Pittsburgh, PA 15237 (US). **WOLF, Roger, P.**; 106 Purvis Road, Butler, PA 16001 (US).

[Continued on next page]

(54) Title: **RESPIRATOR FACEPIECES**



(57) Abstract: The present invention provides an air-purifying respirator facepiece with a removable, one-piece filter element connector. It also has a removable component housing in the lens as well as a nose cup without inhalation valves that prevents fogging of the portion of the lens used for viewing.

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(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(88) Date of publication of the international search report:  
6 March 2003

**Published:**

— with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/15015

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A62B18/08

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A62B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 12 38 780 B (PIRELLI SOCIETA PER AZIONA) 13 April 1967 (1967-04-13) the whole document	1-5,8
A	EP 0 511 593 A (SEKUR SPA) 4 November 1992 (1992-11-04) the whole document	1-8
A	FR 2 764 517 A (APP DE PROTECTION SOC NOUV) 18 December 1998 (1998-12-18) the whole document	1-8
A	US 6 085 748 A (SWORD RANDALL JAY ET AL) 11 July 2000 (2000-07-11) the whole document	1-8



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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- "P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

7 August 2002

Date of mailing of the international search report

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Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Neiller, F

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 02/15015

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-8

Respirator facepiece with a lens and a nose cup, said nose cup including at least one inspiration passage open to the interior of the respirator facepiece without a check valve, said inspiration passage being positioned to circulate air over a viewing area of the lens

2. Claims: 9-13,18-19

Respirator facepiece with a lens and a filtering element connector attachable to the facepiece, the connector including a rear flange and flexible tabs.

3. Claims: 14-17

Respirator facepiece with a lens and a respirator component housing including a seal around its periphery.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/15015

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EP 0511593	A	04-11-1992	IT 1248373 B DE 69214502 D1 EP 0511593 A1	11-01-1995 21-11-1996 04-11-1992
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